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Measuring Current and Power of Different Electrical Engines

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Abstract - The project consists on designing a device controlled by Arduino to measure the power and current consumed by electric motors through three non-invasive current sensors. These sensors operate on the basis of the magnetic flux that occurs in the cable when the current circulates through it. The sensor detects the magnetic flux which, by means of conversions, produces the current intensity, the power at which it works, and displays it on the 2.8 inch TFT display.

When the measurements are obtained, they are stored in a micro SD memory using the SD module of the 2.8 inch TFT display. This device is powered by an adjustable power supply that will allow us to power the Arduino Mega 2560 to 7v which acts as controller of the device, the advantage is to have more pins to program, control the 2.8 inch TFT display, non-invasive sensors, and micro SD module. In turn everything is mounted inside a cabinet of 13 cm x 17 cm x 6 cm, which protects the internal circuit of the device.

The three sensors measure the current of single-phase, biphasic and three-phase electric motors, compare the energy consumption between the lines that power them and determine whether there are large differences between them.

***Key Words*: Keyword 1 – Arduino (Hardware and software platform, Keyword 2 – CT (Current Transformer), Keyword 3 – TFT LCD (Thin-film-transistor liquid-crystal display)**

1. INTRODUCTION

The electric current is defined as the flow of electrons through a conductor medium, electrical devices connected to a power source (voltage) perform a work (power). For example, in a three-phase induction engine, in theory, the current consumed by each phase should be the same; when this is not met it is due to internal engine problems such as a deterioration of the isolation of the stator or by the imbalance of the voltage producing a significant increase of the engine temperature shortening up to 50% its useful life. A sensor is a device that, from the energy of the medium where it is measured, gives a transducible output signal that is a function of the measurement variable.

Sensor and transducer are sometimes used as synonyms, but sensor suggests a more extensive meaning: broadening the senses to acquire a knowledge of physical quantities that, by their nature or size, cannot be perceived directly by the senses. Transducer, on the other hand, suggests that the input signal and the output signal should not be homogeneous.

The sensors are everywhere; in the housing units, the installations of a company, in the machinery of the industries, in the appliances, since they were used for the first time to date, sensors have changed and made life easier for people around the world. Arduino is a development platform based on a free hardware electronic board that incorporates a re-programmable microcontroller, a series of female pins, which allow connections between the microcontroller, different sensors and actuators in a very simple way (mainly with dupont cables).

An electronic board is a PCB (a printed circuit board). Pcbs flat surfaces made from a non-conductive material, which coast from different layers of conductive material. A PCB is the most compact and stable way to build an electronic circuit. So the Arduino plate is nothing more than a PCB that implements a certain design of internal circuitry, so the end user should not worry about the electrical connections that the microcontroller needs to operate, and you can start directly developing the different electronic applications you need.

When it comes to Arduino, the specific model must be specified, since different models of official Arduino plates have been manufactured, each one with a different purpose and varied characteristics (such as physical size, number of I/O pins, microcontroller model, etc.). Despite the various plates that exist all belong to the same family (microcontrollers AVR brand Atmel), this means that they share most of their software features, such as architecture, libraries and documentation.

A TFT screen is a device, the acronym TFT means ("Thin Film Transistor") or thin film transistor. This is a technology based on field effect transistors, that is, an electrode is placed on a glass plate (sheet that conducts electricity), on which thin layers are placed, and when activated by means of the electrode each, the colors are activated, thus forming each pixel.

2. DEVELOPMENT

The following materials were used for the device:

- Arduino Mega 2560

- 2.8 inch TFT LCD
- Processor 3 LM358
- Plastic Cabinet 13 cm X 17 cm X 6 cm
- Three Non-invasive Current Sensors SCT - 100
- 3.5 mm Jack port
- Transformer 120/16 volts and 0.5 amps
- A switch
- Two male banana inputs
- Two female banana inputs
- Two ceramic lentil capacitors
- An electrolytic capacitor of 1000 microfaradia at 35 volts
- An electrolytic capacitor of 1000 microfaradia at 16 volts
- A plug
- Four diodes 1n4007

For the programming of the non-invasive current sensors SCT [100 the base code was obtained from the website *https:///naylampmechatronics.com/blog/51_tutol-sensor-de-corriente-ac-non-invasive-s.html*, from there the code for three sensors was adapted. The programming of the 2.8 inch TFT screen was also found on a website, the base code was also adapted to show a start menu in the language selection (English/Spanish), buttons on/off for each sensor, sensor readings are displayed on the TFT screen once the area of the display where they are displayed is delimited, and at the same time they are stored on a micro SD memory, taking advantage of the fact that the screen has a micro SD module. The code of the module was also found in its base form on another different website, it was adapted for all three sensors, it was even defined how often that information should be saved (for this case the module saves it every second), this also applies for the measurements that the screen displays for each sensor.

The Mega 2560 Arduino plate is energized at 7 volts thanks to a power supply adjusted to the same amount. On the other hand, the TFT screen is powered by 3.3 V. of the mega arduino plate, unlike the screen, the sensors need 5 V.
Continuity is checked on the 3 Jack inputs with the multimeter, this to ensure that the circuit is closed for the sensors when they are connected, proceed to weld the corresponding cables that will go directly to the plate. The design of the power supply was made on the basis of a previous one.

Finally, the Arduino plate, the circuit board of the power supply, and the three sensors are mounted inside the cabinet so as not to disturb each other, the TFT display is mounted on top of the cabinet. Subsequently, tests were carried out measuring the current of three three-phase motors of different voltage (440V and 220V).

Arduino Mega 2560

It is a free hardware board that incorporates a reprogrammable microcontroller and a series of female pins (which are internally attached to the microcontroller I/O pads that allow very simple and convenient connection of different sensors and actuators.

2.8 in TFT LCD

TFT screens are a variation of LCD screens (Liquid Crystal Display). Roughly, an LCD is a glass panel that becomes opaque and its opacity is electrically controlled. LCD panels do not generate their own light but need a backlight provided by some light source (for example, fluorescence or LED). The LCD panel covers the light emitted at certain points, allowing you to generate an image.

Processor LM358

It consists of two independent circuits that are located within the encapsulation that compensate the frequency of the operational amplifier and each operates as a power

supplement operating at different voltage ranges, drainage is also possible under force operations regardless of the magnitude of the voltage supply, its diagram is easy to implement.

Plastic Cabinet 13 cm X 17 cm X 6 cm

It contains the device circuit, the Arduino plate, the LM358 and the power supply.

Non-invasive Current Sensor SCT – 100

SCT-013 sensors are current transformers, instrumentation devices that provide a measurement proportional to the intensity that passes through a circuit. The measurement is performed by electromagnetic induction.

3.5 mm Jack port

The 3.5 mm Jack port is used to transfer the analog audio signal. As in the case of RCA, it is of the female type. These types of ports are usually found on the sound card and can be accessed from the motherboard panel, usually located at the back of the computer.

Transformer 120/16 volts and 0.5 amps

A transformer is an electrical device that increases or decreases the voltage of an AC electrical circuit (there are no direct current transformers), it can also be used to electrically isolate a circuit. It is composed of two independent windings (windings) in an air core or electromagnetic material.

A switch

The switch enables the power supply of the device to be switched on and off.

Male banana input

With it is possible to connect the cables that go from the plug to the power supply of the device by means of the female banana inputs.

Female banana output

They can connect the male banana inputs and to energize the power supply.

Ceramic lentil capacitor

The 0.1uF capacitors are useful to improve the voltage stability of a circuit, as it prevents peaks and electrical noise that voltage sources can generate.

Electrolytic capacitor

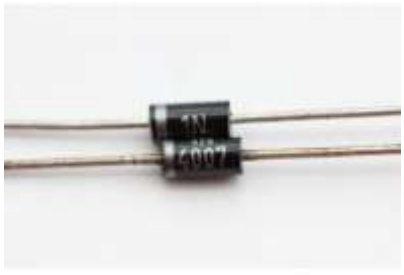
An electrolytic capacitor is a type of capacitor that uses a conductive ionic liquid as one of its plates. Typically with more capacity per unit volume than other types of capacitors, they are valuable in relatively high current and low frequency electrical circuits.

A plug

It connects directly to the power outlet to energize the power supply.

Diode 1n4007

It is the electronic device for converting alternating current into direct current. This is done using rectifying diodes, whether solid-state semiconductors, vacuum valves or gaseous valves such as mercury vapour (currently in disuse).



3. RESULTS

Once connected to the power outlet, the device works when turned on, the 2.8 inch TFT display displays a start menu that allows you to choose the desired language to display the data, sensors measure the current of the desired line without cutting the wires.

Fig. -1: Front view of the device measuring current of a three-phase motor

Fig.- 2: Rear view of the device, see the components inside the cabinet.

It was possible to measure the current of the motors without any inconvenience, the sensors are activated and deactivated according to the choice of which should work thanks to the buttons that were implemented on the 2.8 inch TFT screen.

4. CONCLUSIONS

With the design of this device it was possible to measure the current of the electric motors (especially the biphasic and three-phase) continuously, the user is sure to know how much current is consumed by the motors, and best of all is to be able to monitor them without anyone necessarily being at the place where the measurements are made. This helps maintenance personnel to prevent a possible engine failure due to the difference in current circulating on each of its lines, as mentioned above, this difference in currents may cause the engine to burn. Above all, the priority is to maintain the safety of the installations of companies or universities where electric motors are used for production activities or simply for academic purposes. It can also be said that by knowing the current consumed can be deduced the costs that are generated in matter of electric power, the users can have a better visualization about the performance of the machines, Check them if necessary for sensor readings on the engines.

This will prevent any engine from burning, and therefore maintenance costs will decrease, and failure shutdowns will also decrease. In the company, failure stoppages are very expensive because they are stopped, spent on repairs, and in more severe cases, accidents at work could occur.

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BIOGRAPHIES

Noé Ramírez Rodríguez graduated from the University of the Tlaxcala Valley in Modern Languages, currently a student in Industrial Maintenance Engineering at the Technological University of Tlaxcala, he graduated as T.S.U. in 2018. He worked as a language teacher (English and German) during the years 2013 and 2014, he also worked as a laboratory assistant in the area of quality at Geosyc S.A. de C.V.

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Moisés Sánchez Moredia earned a Bachelor of Arts in Applied Modern Languages, specialized in English as a second language teaching by Universidad Autónoma de Tlaxcala. He holds a Master´s Degree in School Administration and Management by Universidad Internacional de la Rioja (UNIR). From 2016 to 2018, He was the coordinator of the English area in Universidad Tecnologica de Tlaxcala where he currently teaches English in Industrial Maintenance Engineering.

Jonny Carmona Reyes graduated from the Technological Institute of Apizaco in 2010 with a bachelor´s degree in Electronic Engineering, especially in automation and instrumentation. Since to 2013, he has been working as a teacher in the Technological University of Tlaxcala in the Industrial Maintenance career.

María Judith Ortiz Ramos is a professor in the area of Social Sciences at the Technological University of Tlaxcala for T.S.U. and Engineering.

Haynet Rivera Flores graduate in applied linguistics from the Universidad Autónoma de Tlaxcala, she has a specialization in teaching and a master's degree in administrative engineering from the Instituto Tecnológico de Apizaco. She served as a language assistant in the United Kingdom for a period of one year. Trainer of the method for teaching English Rassias. Author of articles presented at national and international congresses and published in indexed journals. Currently working at the Technological University of Tlaxcala, as a research professor and teacher of the English language